JOURNAL OF TRANSLATIONAL NEUROSCIENCES

Plastic changes of innate odor quality by imprinted memory during the critical period in Mice

Hitoshi Sakano

University of Fukui, Japan

Abstract

In the mouse, odor signals detected by olfactory sensory neurons (OSNs) are converted to a topographic map of activated glomeruli in the olfactory bulb (OB). Olfactory information is then transmitted to the olfactory cortex (OC) through synapses with mitral and tufted (M/T) cells. We studied synapse formation and dendrite selection within the glomeruli by analyzing a pair of signaling molecules, Semaphorin (Sema) 7A and its receptor Plexin (Plxn) C1. Sema7A is expressed in OSN axons in an activity-dependent manner, and PlxnC1 is localized to M/T-cell dendrites only during the first week after birth. In the knockout (KO) mice of Sema7A or PlxnC1, initiation of post-synaptic events is perturbed, although targeting of OSN axons to the OB is not affected at all.

During development, there is a narrow time window, neonatal critical period, which allows plastic but irreversible changes in neural circuits. We found that Sema7A/PlxnC1 signaling plays a key role in imprinting the neonatal odor experience. When the newborn is exposed to a particular odorant, Sema7A expression is induced in the responding glomeruli, promoting dendrite maturation of M/T cells and resulting in glomerular enlargement. This early odor exposure establishes imprinting that induces attractive responses to the imprinted odorants, even when the odor quality is innately aversive.

We found that imprinted memory of an aversive odorant 4-methyl-thiazol (4MT), a derivative of a fox odor trimethyl thiazoline (TMT), activates the anterior region of the medial amygdala (MeA) that is known to mediate attractive social responses. The imprinted 4MT memory also activates the medial and posterior regions of the cortical amygdala (CoA) that induces aversive responses to TMT. However, aversive outputs of the CoA is blocked by imprinted memory, suppressing the amygdalo-piriform transition area (AmPir) that induces a stress hormone ACTH.

Olfactory imprinting is needed for proper social interactions as adults. When Sema7A signaling is blocked in neonates by naris occlusion or by conditioned KO, the mice demonstrate aversive responses to the unfamiliar mouse scents leading to ASD (autism spectrum disorders)-like social behavior. KO and rescue experiments revealed that oxytocin in neonates is responsible for imposing the attractive quality on imprinted olfactory memory. These results give us new insights into our understanding of imprinted memory during the critical period and neurodevelopmental disorders, e.g., ASD and attachment disorders, in humans.

Biography

Hitoshi Sakano received his Ph.D. degree from Kyoto University in 1976 for his studies on tRNA-precursor processing using the temperature-sensitive mutants of ribozyme, RNAase P. He then spent one year and half as a postdoc with Prof. John Abelson at UCSD studying yeast tRNA splicing. From 1978, Dr. Sakano worked with Prof. Susumu Tonegawa at Basel Institute for Immunology to solve the problem of antibody diversity. He published five Nature article papers, providing the evidence for combinatorial and junctional diversification of antibody genes. Once independent at UC Berkeley in 1981, Dr. Sakano served as Professor in Immunology from 15 years in the Department of Molecular and Cell Biology. Dr. Sakano, then, relocated to the University of Tokyo in 1995 changing his research field to Neuroscience. Since then, he has been studying neural map and circuit formation in the mouse olfactory system. Dr. Sakano unveiled the molecular bases of one neuron-one receptor and one glomerulus-one receptor rules in olfactory map formation. He also discovered that agonist-independent GPCR activity is responsible for regulating odorant-receptor instructed axonal projection of olfactory sensory neurons. Dr. Sakano is currently Professor Emeritus of University of Tokyo and Senior Professor in Neuroscience at University of Fukui. He is now working on olfactory imprinting and decision making in the mouse olfactory system. Dr. Sakano has more than 100 publications including ~30 research articles in Cell, Science, Nature, and their sister journals.

9th International Conference on Neurological Disorders and Stroke | Rome, Italy | February 28-29, 2020

Citation: Hitoshi Sakano, Plastic changes of innate odor quality by imprinted memory during the critical period in mice, Stroke 2020, 9th International Conference on Neurological Disorders and Stroke, Rome, Italy, February 28-29, 2020, 01